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Charles W. Stewart
Date: February 3, 2004

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF APPEALS AND INTERFERENCES

In re application of	
RASHMI K. SHAH et al.	
Serial No. 09/168,770	Group Art: 1764
Filed October 8, 1998	Examiner: Basia A. Ridley
FLAMELESS COMBUSTOR PROCESS HEATER	February 3, 2004

COMMISSIONER FOR PATENTS
P. O. Box 1450
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Sir:

APPELLANT'S REPLY BRIEF

This is in response to the Examiner's Answer mailed December 3, 2003.

Response to New Points/Arguments Made in the Examiner's Answer

Rejection of Claims 1-7, 13-16 and 18-23 Under 35 U.S.C. § 103(a)

A basic issue in this appeal is whether or not it would have been obvious to one skilled in the art at the time the invention was made "to replace the heater in the apparatus of Ruhl with the heater of Mikus for the purpose of providing more even temperature distribution throughout

the length of the burner and lowering the costs of said apparatus" as contended by the Examiner.

Appellants argued in the Amended Brief that it would not be obvious to replace the heater in the endothermic reaction apparatus of Ruhl with the heater in Mikus for two important reasons: (1) The heater in Ruhl is designed to have a non-uniform or uneven temperature distribution (i.e., higher temperature in the middle portion of the heater with lower temperatures at the ends to allow the use of low temperature seals) and (2) the endothermic chemical reactions of interest to Ruhl require an order of magnitude greater heat flux than the 375 watts/foot typically produced by the heater in Mikus. (As explained in the affidavit by Dr. Mikus, much higher heat fluxes are required to heat flowing chemical process streams than are required to heat the rocky materials found in underground formations which are good insulators).

Regarding reason (1), Appellant explained that a "more even temperature", which Mikus found beneficial in connection with heating underground formations, is <u>contrary to the design</u> of the apparatus of Ruhl which requires a heater having an <u>uneven</u> temperature distribution (to allow the use of low temperature seals). This is true of the apparatuses shown either Fig.1 or Fig. 4 of Ruhl. In the case of the apparatus in Fig. 1 of Ruhl, the highest temperatures will be in flame zone 50 (in the middle portion of the combustion tube 30), with lower temperatures at the upper and lower portions of the combustion tube to allow the use of low temperature seals 32 to join the ends of combustion tube to tube sheets 16 and 18. In case of the apparatus of Fig. 4 of Ruhl, the highest temperatures will be burner zone 68, with lower temperatures at upper an lower portions of combustion tube 30 to permit the use of low temperature seals 32 and plug 66, which it is said "need not resist very hot temperatures and thus could be made of graphite or heat resistant organic cement" (Ruhl, page 5, lines 55-56).

Therefore, it would not be obvious to replace the heater in Ruhl with the heater in Mikus to achieve an "even" or "uniform" temperature distribution throughout the length of the burner, since the design of the apparatus in Ruhl requires a heater having an <u>uneven</u> temperature distribution to generate sufficiently high temperatures in the middle of the heater to complete the desired endothermic reaction, yet have low enough temperatures at the ends of the heater to allow for the use of relatively low temperature seals and/or a plug which needn't resist very hot temperatures, which are stated benefits of the apparatus of Ruhl (Page 3, lines 54-55 and page 5, lines 55-56).

In the first full paragraph on page 8 of the Examiner's Answer, the Examiner found Appellant's arguments to be unpersuasive because they "are relying merely on relative terms such as 'lower' or 'higher' temperature, and not objective evidence, such as actual operating

temperatures in the apparatus of Ruhl or the operating temperature ranges for the seals used in said apparatus."

Appellant submits that the entire disclosure of a reference, including relative terms and information available from the drawings, is objective evidence which must be taken into account in deciding obviousness or unobviousness. Appellant is aware of no authority for the proposition that relative terms contained in a reference, such as "relatively low temperature seals" are not objective evidence and can be ignored.

Accordingly, the fact that the heater in Ruhl is designed to produce an uneven temperature distribution, (i.e., a higher temperature in the middle portion of the combustion than at the ends of the combustion tube to allow the use of relatively low temperature seals and/or plugs) <u>is objective evidence</u> which must be taken into account. Appellant's arguments are not "mere conclusory statements of counsel" but are based on <u>factual evidence</u> taken directly from the disclosure and the drawings of Ruhl and Mikus.

In the last paragraph on page 8 of the Examiner's Answer, the Examiner acknowledges that Ruhl refers to the seals or plugs as "relatively low temperature" and that Ruhl does not explicitly disclose any operating temperature ranges for said seals or plugs. However, the Examiner notes that Ruhl does disclose that the sealing material can be a graphite seal, such as a graphite foil spiral wrapped annular seal (such as Grafoil brand foil from Union Carbide).

The Examiner then, <u>without citing the source of the information</u>, states that the:

> "functional temperature range for typical Grafoil products from Union Carbide is from -400°F to 5400°F (-200°C to 3000°C), for neutral or reducing atmospheres. While the temperature ranges for oxidizing atmospheres are somewhat lower, they can be increased by ensuring that the Grafoil does not come in direct contact with the oxidizing fluid."

Using this new information, and information taken from the background section of Ruhl, the Examiner argues that:

> "Since exemplary endothermic reactions for which the apparatus of Ruhl can be used are operated at temperatures significantly lower than the maximum operating limit for Grafoil seals (e.g. methane steam reforming which is carried out at about 1500°F (see Ruhl, P3/L6-26), the presence of temperatures sufficient for said exemplary reaction to occur in upper and lower regions of the apparatus of Ruhl, in near vicinity of said seals, would not have negative effect on said seals. Therefore, as set forth above and in the final Office action, it is the Examiner's position that replacing the process heater of Ruhl with the process heater of Mikus would be obvious to one of ordinary skill in the art."

The Examiner's position as stated above is untenable for a number of reasons.

First, the Examiner appears to have totally overlooked the fact that the "relatively low temperature seals" are used to hold the combustion tube(s) in place, i.e., to seal the combustion tube(s) 30 to tube sheets 16 and 18. They are not used in the part of the apparatus where the exemplary reaction (e.g., methane steam reforming) is conducted. The exemplary reaction is carried out in catalyst bed 20 and does not occur "in the near vicinity of said seals". Therefore, the fact that the conventional methane steam reforming may be carried out at 1500º F is irrelevant, since seals 32 are used to seal combustion tube(s) 30 which is the heat generating means in Ruhl and thus will have a higher temperature than the temperature of the catalyst bed 20 in which the endothermic methane steam reforming reaction is conducted.

Second, the "about 1500°F" temperature mentioned on page 3, line 25, of Ruhl refers to the temperature of conventional methane steam reforming. The endothermic reaction apparatus of Ruhl is designed to operate at higher temperatures and pressures than conventional reformers in order to achieve high conversion of the hydrocarbon with high thermal efficiency of the process (Ruhl, page 3, lines 50-53). Note that the reformer peak temperature in Table 1, on page 8 of Ruhl, is 850°C (1562°F) for a "Conventional Radiant Reformer", while the temperature is 1170°C (2138°F) for the reformer of Ruhl's invention. Thus, the Examiner is incorrect in assuming that methane steam reforming is carried out by Ruhl at a temperature of about 1500°F. Clearly Ruhl teaches the use of higher than conventional operating temperatures in order to achieve higher hydrocarbon conversions. But the more important point is that the temperature at which methane steam reforming is conducted is not even relevant, since the seals are used to seal the combustion tubes, and are not used in the part of the apparatus in which methane steam reforming reaction would be conducted, as discussed above.

Third, functional temperature ranges recited in the Examiner's Answer for typical Grafoil products (-400°F to 5400°F) are said to be for neutral or reducing atmospheres. As discussed above, the low temperature seals in Ruhl are used to seal the combustion tube(s) 30 to tube sheets 16 and 18. The atmosphere in the combustion tube(s) is an oxidizing atmosphere (i.e., fuel is combusted with air fed through inlet 40 and air manifold 42). Hence, the -400°F to 5400°F functional temperature range for typical Grafoil products cited by the Examiner would not apply when such products are used in an oxidizing atmosphere as is the case in Ruhl. Therefore, the new information obtained by the Examiner from an undisclosed source, would not motivate one skilled in the art to increase the temperatures in the ends of combustion tube to provide an even temperature throughout the length of the burner. To the contrary, one skilled in the art knowing that functional temperature range of Grafoil seals in an oxidizing atmosphere was less than in a

neutral or reducing atmosphere, would not be inclined to increase the temperatures to which the low temperature seals were exposed.

Even though the new information about the functional temperature range of typical Grafoil products under neutral or reducing atmospheres does not support the Examiner's position, Appellant questions the appropriateness of the Examiner's attempt to use this new information at this stage in the prosecution without even disclosing the source of the information. If the Examiner felt a need to rely on new information to support a rejection that is on appeal, it seems the appropriate course of action would have been to reopen prosecution and cite the new reference so Appellant would at least have a chance to review it. In any case, since the new information is not relevant for the purpose the Examiner is trying to use it, and since it does not support the Examiner's position, Appellant assumes that no further action regarding the new information is required.

At the bottom of page 9 the Examiner states:

> "Additionally, even if Ruhl did, arguendo, desire non-uniform temperature distribution throughout the length of the oxidation chamber, the apparatus of Ruhl would benefit from use of a flameless burner in a oxidation zone, since it would eliminate the hot spots within the burner and structures surrounding the burner, said hot spots originating from the radiant heat transfer from the luminous portion of the flame, since elimination of said hot spots would allow for construction of said burner from less expensive materials, as taught by Mikus C2/L4-12. In fact, Ruhl, in Fig. 4 discloses an embodiment wherein burner located in an oxidation zone comprises a fuel conduit comprising a plurality of fuel nozzles and does not have a flame."

While the apparatus shown in Fig, 1 of Ruhl may benefit from use of a flameless burner in the oxidation zone in order to eliminate hot spots, this does not change the fact that the both the apparatuses in Figs. 1 and 4 of Ruhl require an <u>uneven temperature distribution</u> in order to allow the use of low temperature seals. Note that in the apparatus of Fig. 4 of Ruhl all of the fuel nozzles are located in "burner zone" 68, which will result in the highest temperatures being in the middle portion of combustion tube 30, while the upper and lower portions of combustion tube have lower temperatures to allow for the use of relatively low temperature seals 32 and plug 66, which it is said "need not resist very hot temperatures and thus could be made of graphite or heat resistant organic cement" (Ruhl, page 5, lines 55-56). Thus, the apparatus in Fig. 4 Ruhl, although having a flameless burner, still requires a burner having an <u>uneven</u> temperature distribution to allow the use of low temperature seals.

Therefore, if one skilled in the art after reviewing the disclosure of Ruhl, wanted to replace the flame type burner in used in the apparatus of Fig.1 with a flameless burner to

eliminate hot spots and to use less expensive materials, he or she would chose the flameless burner design in Fig. 4 of Ruhl, which like the burner in Fig. 1 of Ruhl has an uneven temperature distribution and would allow the use of low temperature seals. One skilled in the art would not chose to replace the heater in Fig. 1 of Ruhl (or for that matter in Fig. 4 of Ruhl) with the flameless heater of Mikus as contended by the Examiner, because the heater in Mikus is said to produce an even temperature distribution, while both the heaters in Figs 1 and 4 of Ruhl require an uneven temperature distribution to allow the use of low temperature seals.

In response to Appellant's second basic reason why it would not be obvious to replace the heater in the endothermic reaction apparatus of Ruhl with the heater in Mikus (i.e., the endothermic reactions of interest to Ruhl require an order of magnitude greater heat flux than the 375 watts/foot typically produced by the heater in Mikus), the Examiner takes the position that one of ordinary skill in the art would know that the combustion and heat flux of a burner can be affected by a "multitude of variables" and that the manipulation of these variables to produce an order of magnitude increase in heat flux is within the skill of the art.

Appellant's pointed out in the Amended Brief, the fact that there may be "a multitude of variables" which could be modified or manipulated by one skilled in order to meet the claimed invention is not sufficient by itself to establish *prima facie* obviousness without some objective reason to combine the teachings of the references. *Ex parte Levengood*, 28 USPQ 1300 (Bd. Pat. App. & Inter. 1993). In response the Examiner cites several teachings in the references, which the Examiner contends would make it obvious to replace the heater in Ruhl with the heater in Mikus. They do not for the following reasons.

For example, Ruhl's teaching on page 5, line 38-39, that "as many as many thousands of combustion tubes could be incorporated in an appropriate size reformer apparatus", refers to combustion tubes in Figs. 1, 2 and 3 of Ruhl which have higher temperatures in the flame zone in the middle portion of the combustion tube and lower temperatures at the ends to allow the use of relatively low temperature seals. (The combustion tube in Fig. 4 of Ruhl also has an uneven temperature distribution.) Thus, the fact Ruhl teaches many combustion tubes having an uneven temperature distribution can be used in a reformer apparatus, does not provide a motivation to replace these combustion tubes with the different type of heater disclosed in Mikus, which produce an even temperature distribution.

Likewise, the teaching on page 7, lines 4-6 of Ruhl, that "The maximum temperature of the combustion gases within the combustion tubes may be varied by adjusting the fuel composition and the fuel and air flow rates" refers to varying the maximum temperature of the combustion tubes in Ruhl which have an uneven temperature distribution. This teaching does not tell one skilled in the art how to produce a order of magnitude (i.e., a ten fold increase) in the

rate of heat flux in the heater in Mikus, and does not provide any motivation to replace the heater in Ruhl which has an uneven temperature distribution with the heater in Mikus which has an even temperature distribution.

Finally, the teaching cited by the Examiner in col. 5, lines 15-25, of Mikus that "The heat that can be transferred into the formation increases significantly with increasing casing diameter" and that "A casing of between about 4 and about 8 inches in internal diameter will typically provide the optimum trade-off between initial cost and heat transfer", may suggest a means to optimize the heat transfer to an underground formation, but does not provide motivation to replace the heater in Ruhl.

Ruhl clearly prefers the "use of small-diameter ceramic combustion tubes" to facilitate "a denser packing of burner tubes than has been previously available in prior art apparatus" (Ruhl, page 5, lines 39-40). "The preferred combustion tube inside diameter is usually equal to the tube separation distance (expressed as inside tube to inside tube surface). Thus, if the separation distance were 0.4 inches, the preferred tube ID would be 0.4 inches for a centerline spacing of 0.8 inches" (Ruhl, page 6, lines 19-21).

In view of Ruhl's desire for a compact apparatus which is achieved by employing many densely packed, relatively small diameter (e.g., 0.4 inch) burner tubes, it is submitted one skilled in the art would not be motivated by Mikus teaching of heat injectors with an optimum diameter of 4 to 8 inches for heating underground formations, to replace the densely packed, small diameter, burner tubes of Ruhl with the relatively large diameter burner tube preferred by Mikus. Such replacement would not result in a compact reactor, would not provide the same heat flux as many densely packed small diameter tubes, and in any case would not provide the uneven temperature distribution needed to allow for the use of low temperature seals and/or plugs. Mikus teaching that the heat transferred to the formation can be increased by increasing casing diameter is in fact a reason for not replacing the heater in Ruhl with the heat injector in Mikus, since Ruhl achieves a high heat flux by using many tubes of a small (reduced) diameter so that they can be densely packed.

In the second full paragraph on page 11 of the Examiner's Answer, it is stated:

> "Further, the examiner notes that a reasonable expectation of success for this proposed use of flameless heater of Mikus in the apparatus of Ruhl is supported by the fact that Ruhl in Fig. 4, discloses an embodiment wherein burner located in an oxidation zone comprises at least one fuel conduit comprising a plurality of fuel nozzles and does not have a flame."

This argument overlooks the fact that the flameless heater used in the embodiment shown in Fig. 4 of Ruhl is significantly different from the flameless heater of Mikus in two

important respects. First, the flameless burner shown in Fig. 4 of Ruhl has the entire plurality of fuel nozzles in burner zone 68 in the middle portion of the combustion 30 and therefore produces an uneven temperature distribution as discussed above. Second, the flameless heater in Mikus produces a relatively low heat flux, in the order of 375 watts per foot, while the flameless heater used in the embodiment shown in Fig. 4 of Ruhl must produce a much higher *rate of heat flux in order to complete the types of endothermic reactions of interest to Ruhl. Therefore, the fact that the flameless heater in Fig. 4 of Ruhl (which has an uneven temperature distribution and a high rate of heat flux) can be used in an apparatus for conducting endothermic reactions, does not create a reasonable expectation of success that a different type of flameless heater (such as the heat injector of Mikus) which has an even temperature distribution and produces a relatively low rate of heat flux (e.g., 375 watts per foot) can be used for this purpose.

On pages 26-27 of the Amended Appeal Brief, Appellant pointed out some the significant differences between the combustion tubes of Ruhl and the heat injector tubes used by Mikus to inject heat into underground formations to enhance oil recovery. These differences include not only the size of the tubes (e.g., length and diameter), but also the nozzle sizing and spacing (orifices sized to produce a nearly uniform temperature profile within the wellbore in the case of Mikus) and the location of the nozzles on the fuel conduit (e.g., all of the nozzles in "flame zone" or "burner zone" in the case of Ruhl, with no nozzles at the ends of the combustion zone to allow the use of low temperature seals).

On page 12 of the Examiner's Answer, the Examiner finds the Appellants argument unpersuasive stating:

> "It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the size of combustion tubes of Mikus to fit in the apparatus of Ruhl, said modification including changes in, among others, the length and diameter of fuel and combustion air conduits, since such modifications would have involved a mere change in size of a component. A change in size is generally recognized as being within the ordinary skill in the art. In re Rose, 220 F.2d 459, 105 USPQ 237 (CCPA 1955). Additionally, where the only difference between the prior art and the claims is a recitation of relative dimensions of the claimed device, and the claimed device is not patentably distinct from the prior art device. Gardner v. TEC Systems, Inc., 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), cert. denied, 469 U.S. 830, 225 USPQ 232 (1984).

Appellant submits the rationale of *In re Rose* and *Gardner v. TEC Systems, Inc.,* does not apply to the present case, since replacing the heater in Ruhl with the heat injector of Mikus involves much more than "a mere change in size". There are significant structural differences

and performance differences between the heaters in Ruhl and the heat injector in Mikus as discussed below.

The heater used in the apparatus shown in Fig. 1 of Ruhl is structurally different from the heat injector in Mikus in that the fuel feed tube 34 in Fig. 1 of Ruhl has a single fuel nozzle at one end of the fuel feed tube, has a flame zone 50 in the middle portion of the combustion tube 30, and low temperature seals 32 at both ends of the combustion tube. While the combustion tube in Fig. 4 of Ruhl has a plurality of fuel nozzles in fuel tube 60, all of the fuel nozzles are in the middle portion of the combustion tube in "burner zone" 68. The combustion tube in Fig. 4 of Ruhl also is sealed at both ends to tube sheets using low temperature seals 32, and has a plug 66 at the upper end of fuel tube 60.

In contrast, the heat injector in Fig. 3 of Mikus has no fuel nozzles in the upper part of fuel gas conduit 12 which may be hundreds of feet in length, but has fuel nozzles spaced along the length of the bottom portion of the fuel conduit that is in the formation. The heat injector in Mikus has no low temperature seals at the ends of the combustion tube, and no plug at the end of the fuel conduit. The wall of the heat injector in Mikus is actually well casing 4 which is cemented into overburden 1 and the formation to be heated 2 using a high temperature cement. (Mikus, Fig. 3 and col. 7, lines 49-53).

The heaters in Ruhl also perform very differently from the heat injector in Mikus. The heaters in Ruhl are designed to produce heat at a relatively high rate of heat flux and have an have a non-uniform or uneven temperature distribution, while the heat injector in Mikus produces heat at a relatively low heat flux (e.g., 375 watts per foot) and has a uniform or even temperature distribution.

Thus, clearly more than "a mere change in size" is involved in attempting to modify the heat injector in Mikus fit into the apparatus of Ruhl. In view of the significant <u>structural differences</u> and <u>performance differences</u> between the heaters in Ruhl and the heat injector in Mikus, it would not be obvious to replace the heater in Ruhl with the heat injector in Mikus.

In response to Appellant pointing out that the heat injector in Mikus is not a "process heater" as this term is used in the present specification and claims and that Mikus apparatus does not have a "process chamber", the Examiner on page 13 of the Examiner's Answer cites a broad dictionary definition of the term "process", and argues that in view this definition "the heater of Mikus reads on the process heater recited in the instant claims". Since the Examiner is using Mikus as a 103 reference, not as a 102 reference, Appellant is unclear what the Examiner means by the heater in Mikus "reads on" the instantly claimed process heater.

One skilled in the art reading the present specification and claims would know that the term "process heater", <u>as used in the present specification and claims</u>, refers to a heater

designed to provide controlled heat to an endothermic chemical process, and that the term "process chamber", as used in the present specification and claims, refers to a chamber in which an endothermic chemical process is conducted. The heat injector in Mikus, on the other hand, has nothing to do with endothermic chemical processes, has no "process chamber" and does not need a "process chamber" since it is used to inject heat into a subterranean formation (i.e., a geological structure) at a relatively low heat flux to enhance oil recovery. Therefore, while the heat injector in Mikus may superficially look similar to the process heater of the invention, and contain some of the same elements, it is not a "process heater" and does not have a "process chamber" as these terms are used in the present specification and claims. Furthermore, Mikus is directed to a totally different problem, i.e., how to enhance oil recovery by injecting heat into hydrocarbon-containing, rocky materials located hundreds or even thousands of feet underground. For all these reasons, one skilled in the chemical arts would not consider the heat injector in Mikus to be a "process heater" as this term is used in the present specification and claims, and would not be motivated to replace the heater in Ruhl with heat injector of Mikus, the dictionary definition of "process" notwithstanding.

After acknowledging on page 10 of the January 12, 2003 Office Action that Mikus does not explicitly disclose nozzles being distributed along substantially entire length of the oxidation chamber, the Examiner, on page 13 of the Examiner's Answer, now the takes the position that perhaps the Mikus reference does explicitly disclose this feature on the basis that a skilled artesian would define the oxidation chamber in the heat injector of Mikus "to be confined to only the parts of said conduits within the formation to be heated". The remaining parts of the air and fuel conduits "would be defined merely as feed conduits to said oxidation chamber". The heat injector shown in Fig. 3 of Mikus shows the combustion air conduit 10 and a fuel gas conduit 12 as two continuous conduits. Mikus does not define portions of these conduits as feed conduits or as an oxidation chamber as the Examiner speculates one skilled in the art would. However, assuming arguendo the Examiner is correct, this still would not provide any motivation to replace the heater in Ruhl with the heat injector in Ruhl, because Mikus clearly discloses that the plurality of orifices along the fuel conduit within the formation "are sized to accomplish a <u>nearly even temperature</u> distribution within the casing" (Col. 5, lines 46-48). (Emphasis added). Thus, replacing the heater in Ruhl, with only those portions of the fuel and air conduits within the formation, would still result in a heater which produces an even temperature distribution along the length of the combustion tube, while Ruhl requires an uneven temperature distribution, i.e., lower temperatures at the ends of the combustion tube to allow the use of low temperature seals.

R jection of Claims 17 and 24 Und r 35 U.S.C. §103(a)

Claims 17 and 24 claim the embodiment of the invention wherein the oxidant is preheated by heat exchange with effluent from the process chamber. The Examiner acknowledges on page 13 of the Examiner's Answer, that none of the references explicitly teach using heat available from the process effluent to preheat the oxidant, but states the principle that one can lower the operating costs by using heat that is already available in the system is so well known that no reference should be necessary. While the general principle of using available heat in the system to reduce operating costs may be well known, in many cases there are multiple sources of heat in a system, and multiple purposes for which heat could be used. Also, there may be equipment constraints which might limit the ability to use some streams for heat exchange, or might make some heat exchanges more favorable than others. Therefore, the fact the one skilled in the art may be familiar with the general principle of heat exchange, does not make any and all inventions based on that principle obvious, especially where there are various sources of heat in a system and various ways in which heat could be used.

Apparently recognizing this, the Examiner continues to rely on Minet et al which it is said teaches "that heat of effluent of a process chamber is being used to preheat a feed stream for said process chamber". Actually, the hot product gases in Minet et al are not used to "preheat a feed stream". Rather, they are used to heat the counter current flowing reactant mixture (e.g., steam and reformable hydrocarbon) inside reaction chamber 14 (Col. 5, lines 63-68). More importantly, Minet et al does not teach preheating the oxidant (combustion air) which enters the burner assembly through burner nozzle 42 whereupon it is mixed with burner fuel and combusted (Col. 6, lines 44-49). Combustion air is not part of the "reactant mixture" in Minet et al, and in fact is not preheated at all since Minet et al. uses an infrared burner which does not require preheating of the oxidant.

Therefore, if one skilled in the art were to apply the teachings of Minet et al to Ruhl, he or she would use hot product effluent exiting packed bed 20 in the apparatus of Ruhl to heat the reactant mixture in Ruhl (e.g., hydrocarbon and steam) which enters the reformer through inlet 22. Minet et al does not teach or suggest using the hot product gases to preheat the "oxidant", since the oxidant in Minet et al is not preheated and does not require preheating. It is also pointed out there are other heat sources available in Ruhl, such as the exhaust gas in exhaust manifold 52, or the exhaust gas leaving exhaust exit 54, which could be used to for heat exchange purposes. Thus, if one skilled in the art wanted to utilize available heat from the system in Ruhl, there are several sources of heat from which to choose and a number of different purposes for which the available heat could be used. It is submitted that the particular heat source (process effluent) and the particular use (to preheat oxidant) recited in claims 17

and 24, would not be obvious from Minet et al which teaches using hot product gases for a quite different purpose, i.e., to heat a counter flowing reactant mixture inside the reactor.

Conclusion

For all of the foregoing reasons and well as those stated in the Amended Brief, and in view of the affidavit submitted by Dr. Mikus, it is submitted that claims 1-7 and 13-24 are patentable over the cited references. Accordingly, it is respectfully requested that the action of the Examiner in finally rejecting these claims be reversed, and the application be passed to issue.

Respectfully submitted,

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